

INL's Power and Energy Real-Time Laboratory is equipped with tools to test, validate and develop solutions for recent challenges facing the modern power grid.



Power and Energy Real-Time Laboratory

Modernizing power systems with at-scale testing and emulations

The power grid infrastructure faces diverse challenges in modern times. To ensure reliable and economic operation of the evolving power grid, there is a need to develop new technologies, methods and

devices; and to simulate and validate them prior to field deployment.

Idaho National Laboratory's advanced modeling capabilities can incorporate real-world data, hardware and software into real-time simulations. We have

diverse expertise and the ability to cosimulate electrical, thermal and mechanical systems. Plus, we can integrate with INL's microgrid test beds and with simulation resources at other national laboratories.

The Power and Energy Real-Time Laboratory (PERL) has advanced capabilities for modeling the power grid. Testing and refining a digital real-time simulator (DRTS) approach include the ability to integrate power systems hardware and software into simulations (hardware- and controller-in-the-loop). PERL addresses imperative problems associated with diversity of energy resources and varied production scales using cosimulation of electrical, thermal and mechanical systems.



Researchers can interface power and energy device models, controllers and power hardware into digital real-time simulation (DRTS) racks.

Changing the World's Energy Future

Testing Capabilities

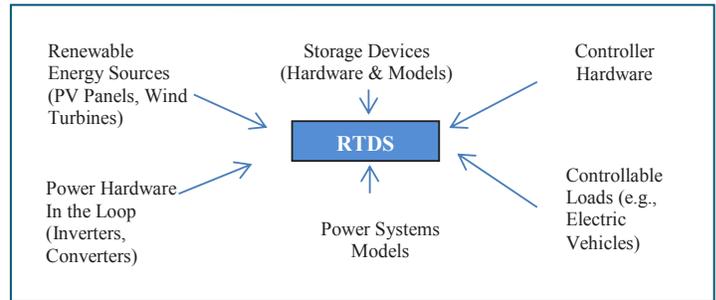
INL's DRTS racks have been configured for simulations requiring Power-Hardware-in-the-Loop (PHIL) and Controller-Hardware-in-the-Loop (CHIL). An on-site microgrid includes micropower sources controlled via power electronics that look to the grid like a single controlled unit.

Also, dynamic distribution grid models and microgrid models from the Consortium for Electric Reliability Technology Solutions (CERTS) are available to carry out power and energy device testing per various technical standards. The lab also has a grid emulator, Chroma 61860, to mimic real-world events in the power grid using DRTS. The grid emulator can put out single-phase or three-phase voltage and current in AC or DC form. INL researchers carry out dynamic simulations using physical hardware and controllers to test and develop new control algorithms, formulate protocols, characterize devices and validate industry models and data. In addition, a communication network simulator has been integrated to replicate cybersecurity events in the power grid — ranging from dropped data packets to malicious attempts to hack the grid.

New Possibilities

The combination of testing capabilities at the PERL opens new possibilities for

- Integrated power and energy device testing.
- Testing interoperability of new grid devices and services.



PERL facilitates integrate grid devices, controllers and power hardware for dynamic simulation and evaluating real-world scenarios.

- Cosimulation of electrical, mechanical and thermal systems.
- Control-hardware-in-the-loop (CHIL) simulations.
- Power-hardware-in-the-loop (PHIL) simulations.
- Rapid prototyping of power system controllers.

CHIL is one of the most preferred methods for rapid prototyping of controllers that will eventually be implemented in the field. Control algorithms are programmed into hardware that is connected to the DRTS running power system simulations. The real-time execution scheme enables researchers to evaluate both algorithm and hardware performances in real-world settings.

Research Excellence

The PERL has built a reputation through its pioneering contributions to the power systems community.

Researchers at INL and the U.S. Department of Energy's National Renewable Energy Laboratory successfully demonstrated the ability to connect grid simulations at the two labs for real-time interaction and data exchange.

They then expanded this effort to demonstrate the Global Real-Time Super Lab, which links

resources from three national labs, three American universities and two European universities.

This demonstration enhances the opportunities for collaborative research between scientists separated by large geographical distances.

The PERL is involved in front-end controller development for advanced grid service devices, including electric vehicles, fuel cells, supercapacitors, electrolyzers and power electronics.

It was a critical component of a collaboration to build a smart microgrid on the trust lands of a sovereign Native American tribe in northwestern California. A similar project will improve grid resiliency for the isolated town of Cordova, Alaska.

The lab's experts also are improving grid stability by undertaking projects that leverage hybrid energy storage systems. Examples include options such as pump-hydro storage, run-of-the-river hydropower plants and even generators from decommissioned coal-fired power plants, all of which can supply rotational inertia for electrical and mechanical cosimulation.

For more information

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